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Title: LDRD Impacts on Mission

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LDRD Impacts on Mission

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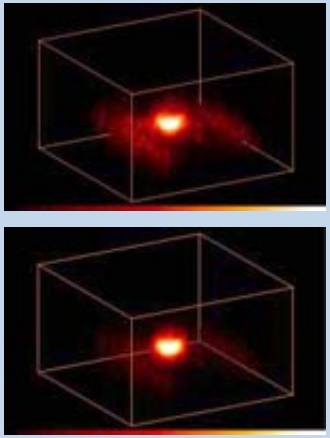
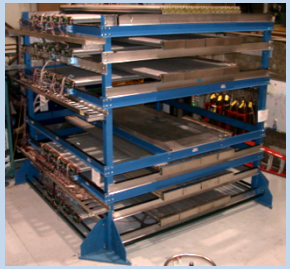
Nuclear Detection with Muons

Research

Large area detectors from nuclear physics were applied to measure the scattering of muons by nuclear materials or their shielding.





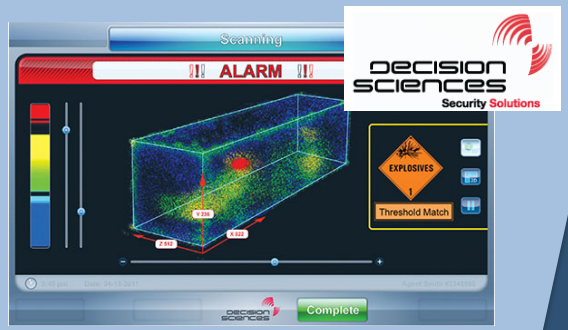
Using muon energies, as well as their deflections, produces radiographs that discriminate more precisely between materials.

Materials that most strongly deflect muons have high atomic numbers and high number densities.

Development

Simulation and experiment proved that cosmic ray muons can detect nuclear material in a background of normal cargo.

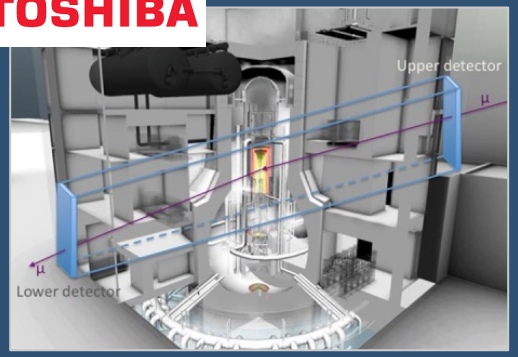
- Detects nuclear material with *no radiation hazard*
- CRADA with Decision Sciences implemented muon tomography in a detection system currently in use at the Freeport Container Port in the Bahamas
- Tested in the high background of the University of New Mexico research reactor



Mission Impact

Detecting shielded nuclear material is faster and safer than ever with muon tomography – fewer slow, costly, and dangerous manual inspections are needed.

TOSHIBA

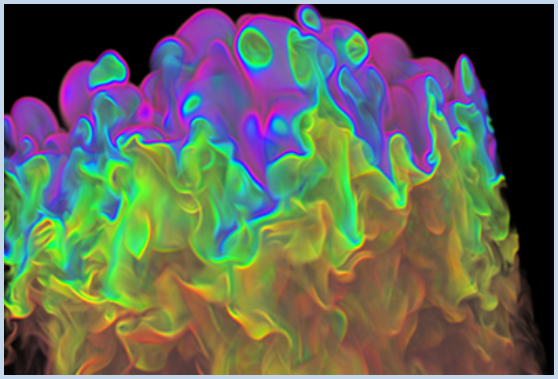


A system using muon detectors will determine the exact locations of the molten cores of the damaged Fukushima Daiichi reactors.

Testing Simulation Codes with Astrophysics

Research

Use weapons simulation codes to model supernovae observations.

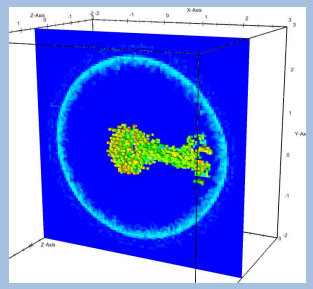


- Modern diagnostics of supernova are arguably better than NNSA Laboratory high energy density experiments
- Fundamental understanding of supernova requires modeling highly turbulent plasma with multiple nuclear reactions

Development

Software tested with supernova is now used extensively within the Los Alamos ASC program

- Past verification and validation efforts have trouble detecting issues that are at the 10-30% level for many mission problems
- Pushing to more extreme regimes allows us to more easily identify and fix code issues

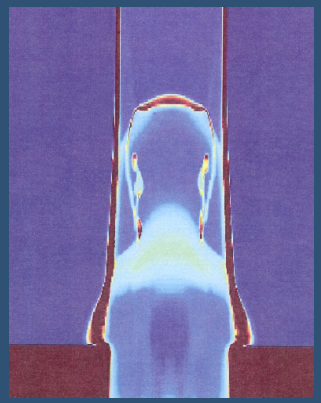


Modeling ^{44}Ti in Cassiopeia A Supernova

Nucleosynthetic yields and light-curves provide much needed data for NASA missions such as Swift and NUSTAR.

Mission Impact

ASC codes and physics are tested in very specific regimes - minor problems in one regime may be critical in others.



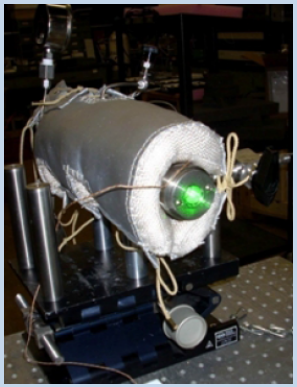
Modeling tools and nuclear cross-section measurements are building capabilities needed for nuclear energy and nuclear forensics

Extensive recruitment of technical staff into nuclear design divisions at Los Alamos

Nuclear Forensics

Research

Develop combined Laser-induced breakdown spectroscopy (LIBS) and Raman spectroscopy instrumentation to analyze elemental compositions in a variety of samples.



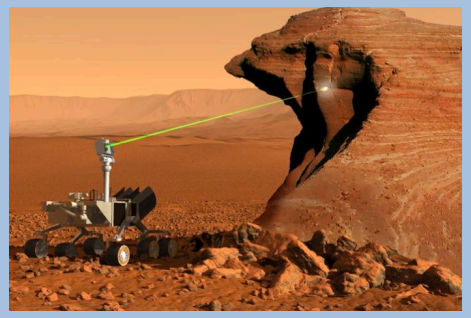
High-pressure, high-temperature chamber used to simulate conditions on Venus for analysis by LIBS and Raman spectroscopy.

- Combined molecular and elemental composition techniques in one instrument enable more accurate/ complete identification of samples
- An integrated Raman-LIBS instrument is sensitive to mineralogy in geological samples *and* can also determine elemental compositions

Development

Raman-LIBS detects the presence of nuclear material in a matter of minutes, with little to no sample preparation.

- Safe, portable, accurate, cost-effective tool for treaty verification
- Part of the IAEA "tool box" for international inspections related to nuclear materials
- A CRADA with Chevron is developing LIBS for oil refinery safety inspections (post 2012 explosion in California)
- Onboard Mars rover, Curiosity



Mission Impact

Backpack LIBS inexpensively takes atomic emission analysis from a traditional laboratory setting into the field, making it possible to detect, verify, and study critical materials.

LIBS is in backpack form for use by IAEA inspectors.

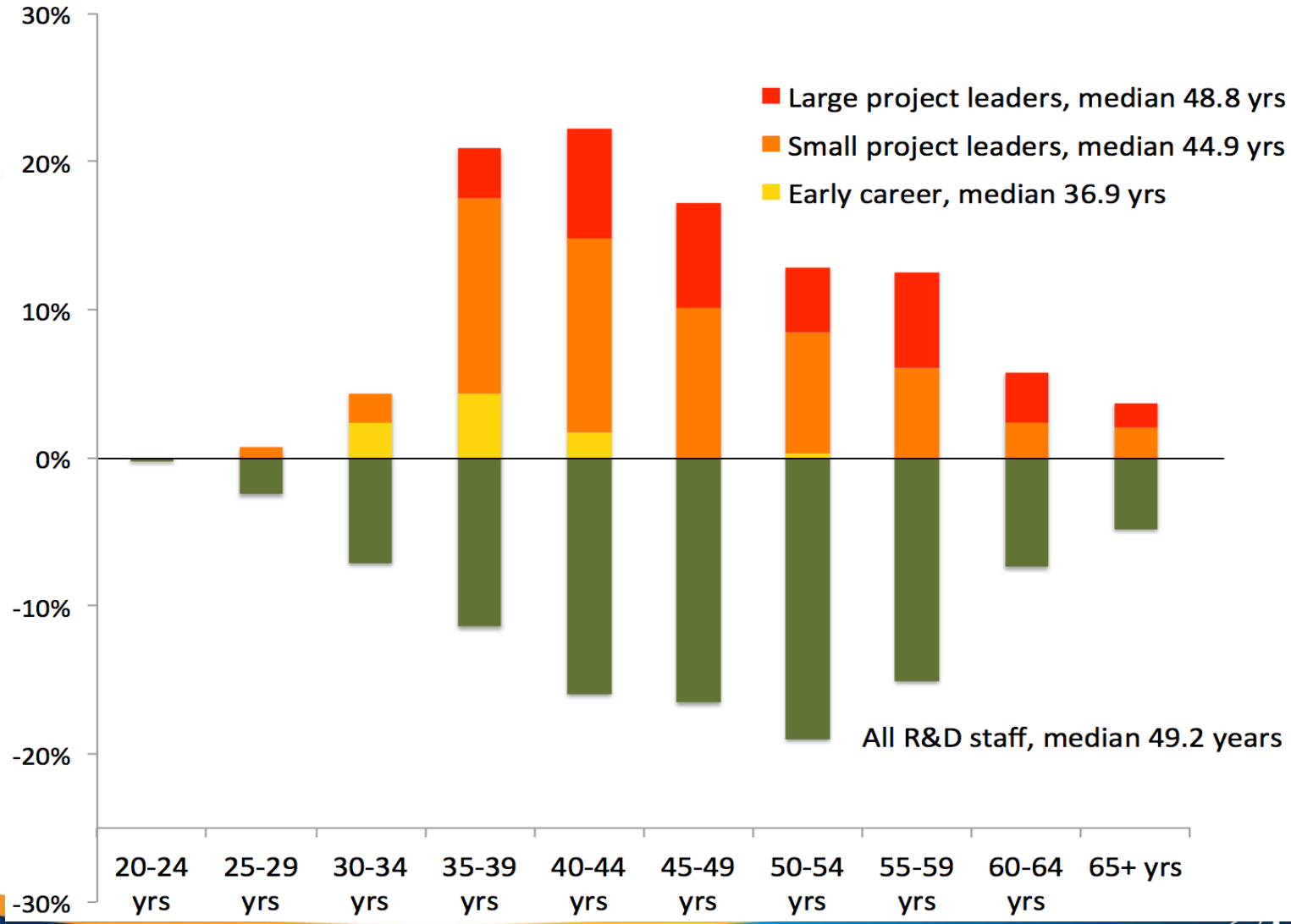
Gemini Experiments Depend on Staff Recruited by LDRD

LDRD sets the foundation for integrated experiments and attracts next-generation researchers to carry out future work in critical mission areas. For example, LDRD recruited all the early-career contributors to the Gemini project.

- Hydro experiments have been essential to the weapons program since 1943
- Gemini diagnostics significantly enhance the stockpile stewardship mission to better understand the physics performance of a nuclear weapon
- The research team has the expertise needed for modern stewardship tools
  - Physics modeling
  - Diagnostics
  - Fabrication
  - Engineering

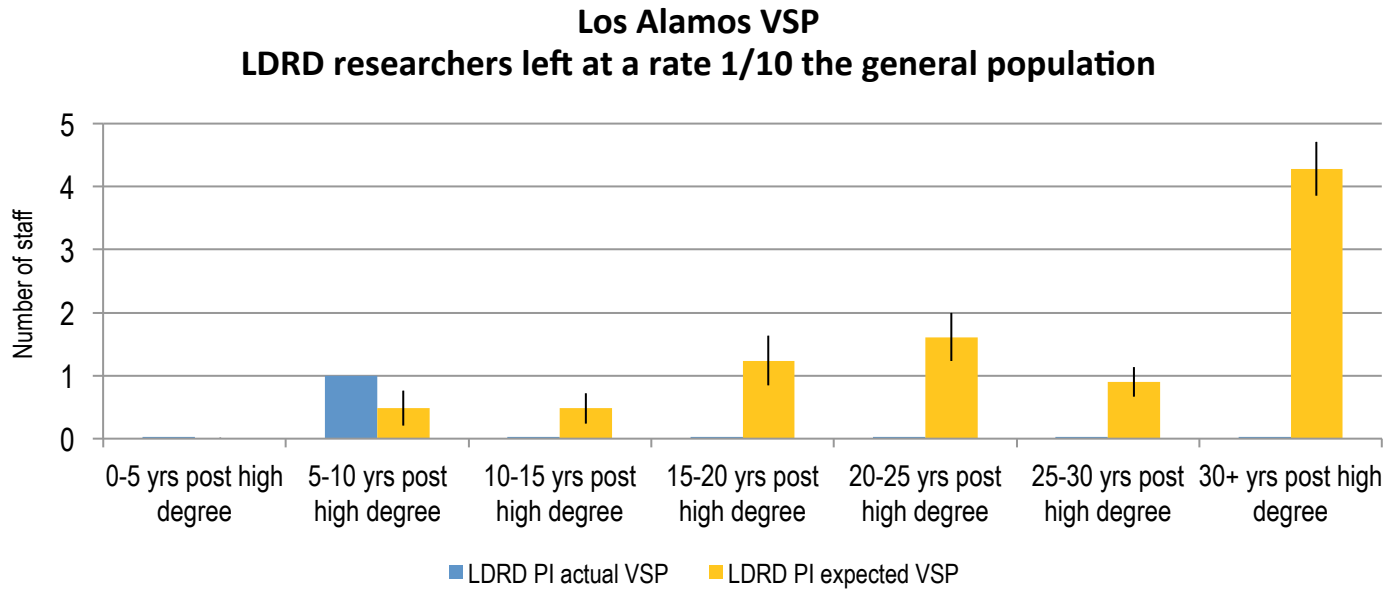
Gemini Experimental Series Core Team

LDRD Develops and Retains R&D Staff At All Career Stages



LDRD Has a Strong Effect on Retention

Analyses of a recent voluntary separation plans at the NNSA laboratories show LDRD improved the retention of key staff, proving that LDRD is essential for retaining critical R&D talent.



FY15 Impact on DOE Missions